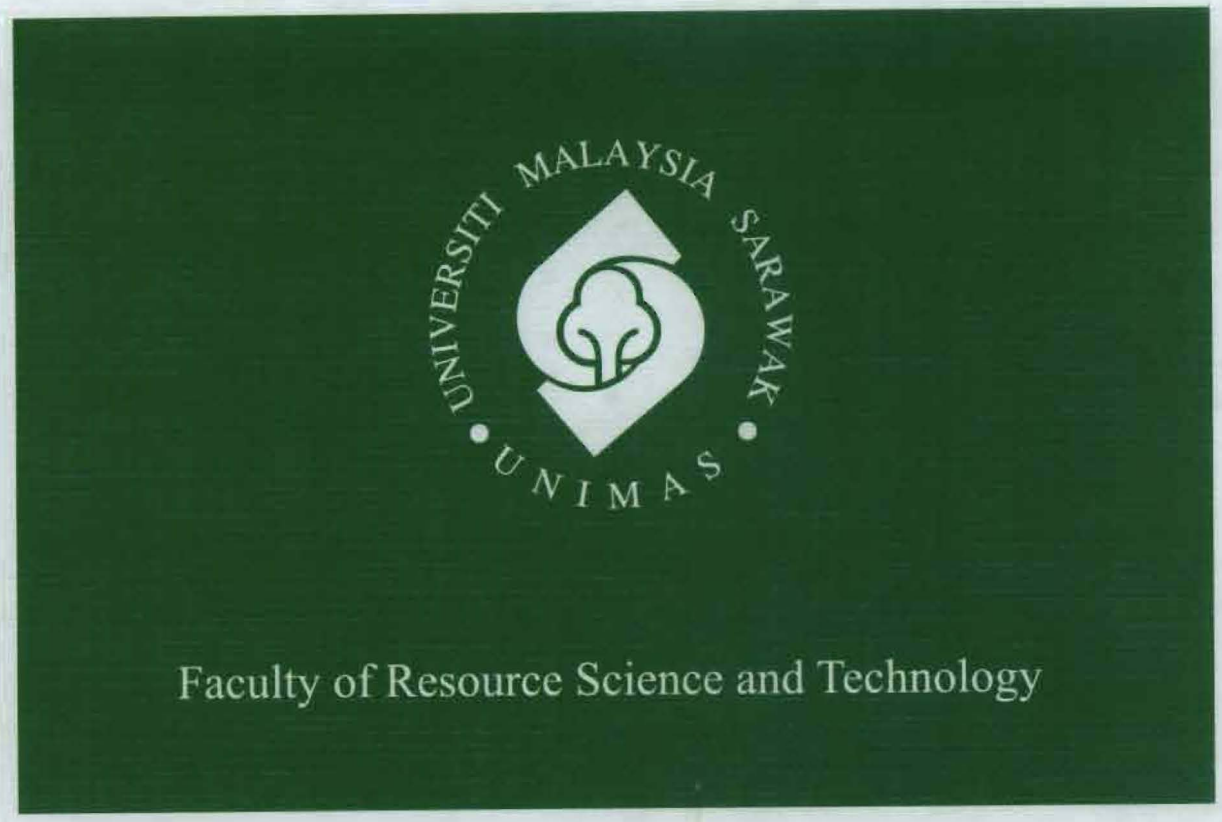

DIVERSITY OF BEETLES (COLEOPTERA) IN MOUNT SERAMBU, BAU, SARAWAK

Sobiratul Addawiyah Binti Ismail

Bachelor of Science with Honours
(Animal Resource Science and Management)
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DIVERSITY OF BEETLES (COLEOPTERA) IN MOUNT SERAMBU, BAU, SARAWAK

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This project is submitted in partial fulfilment of the requirements for the degree of Bachelor of Science with Honours
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DECLARATION

No portion of the work referred to in this dissertation has been submitted in support of an application for another degree of qualification of this or any other university or institution of higher learning.

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LIST OF ABBREVIATIONS

UNIMAS	Universiti Malaysia Sarawak
FRST	Faculty of Resource Science and Technology
IBEC	Institute of Biodiversity and Environment Conservation
km	Kilometer
m	Meter
cm	Centimetre
mm	Millimetre
LE	Lower Elevation
UP	Upper elevation
PAST	PAlaeontological STatistics

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Diversity of Beetles (Coleoptera) in Mount Serambu, Bau, Sarawak

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ABSTRACT

A total of 1602 individuals, representing 122 species consist of 65 subfamilies from 26 families of beetles were captured during this study at Mount Serambu, Bau, Sarawak within 22 days by using three methods which were beating, hand picking and Modified Pennsylvania light trap. Family Chrysomelidae represented the most diverse and common group at the sampling site with 25 species. The most abundant species was *Ozomena* sp. (F: Chrysomelidae). However, some groups of beetle are considered low in abundance because they are very low in number of individuals as well as species numbers. Most of them were encountered from the lower elevations. The overall Shannon Diversity Index was 2.276. Furthermore, there is a significant difference between species diversity of beetle in lower elevation and upper elevation at Mount Serambu when the Shannon Diversity index had been tested with Shannon Diversity Index t-test, $t_{calculated} > t_{critical}$ (5.046>1.96). The species diversity index at lower elevation is H'= 3.4149 higher than at the upper elevation, H'=2.9541. The difference of species diversity between both elevations was influenced by vegetation types existed in that elevation.

Keywords: Beetles, Coleoptera, Mount Serambu, species diversity, abundance

ABSTRAK

Sebanyak 1602 individu kumbang mewakili 122 spesis yang terdiri daripada 65 subfamili dan 26 famili telah ditangkap sepanjang kajian di Gunung Serambu, Bau, Sarawak iaitu selama 22 hari dengan menggunakan tiga jenis kaaedah iaitu memukul, menggunakan tangan dan perangkap lampu 'Modified Pennsylvania'. Famili Chrysomelidae mewakili kumpulan yang mempunyai kepelbagaian spesis paling tinggi dan paling kerap dijumpai di tempat kajian dengan 25 spesis. Kelimpahan spesis yang paling tinggi ialah Ozomena sp. (F: Chrysomelidae). Walau bagaimanapun, sesetengah famili dianggarkan sebagai kurang kepelbagaian kerana mempunyai bilangan individu dan bilangan spesis yang rendah. Kelimpahan kumbang dijumpai adalah lebih tertumpu pada aras rendah di Gunung Serambu. Kepelbagaian Shannon untuk keseluruhan ialah 2.276. Terdapat perbezaan ketara di antara kepelbagaian spesis kumbang pada aras bawah dan aras atas di Gunung Serambu apabila Indeks Kepelbagaian Shannon diuji oleh kepelbagaian t-test Shannon, $t_{kiraan} > t_{kritikal}$ *(5.046 >1.96). Indeks kepelbagaian spesis pada aras rendah iaitu H'= 3.4149 adalah lebih tinggi daripada aras tinggi, H'=2.9541. Perbezaan kepelbagaian spesis di antara kedua-dua aras adalah dipengaruhi oleh jenis vegetasi pada aras tersebut.*

Kata kunci: Kumbang, Coleoptera, Gunung Serambu, kepelbagaian spesis, kelimpahan

CHAPTER 1

INTRODUCTION

Insects are the most diverse group in animal kingdom and believed to exists on earth at least for 400 million years ago (Grimaldi and Engel, 2005). During that time, they become evolved in many directions for adaptation to life in almost every types of habitat (Triplehorn and Johnson, 2005). They are nearly up to one million species of insects distributed all over the world was described and named. The species can be justified as a group of interbreeding natural populations which is isolated reproduction from other such groups (Cassie, 2007).

Based on the combination of some similarities such as the types of mouthparts, wings, metamorphosis and habitats, class Insecta are divided into 29 orders (Said, 1983). Coleoptera are among the prominent and most successful order within Class Insecta referring to their 40% of all insects or fifth of all living organism (Arnett *et al.,* 1980). Beetles (O: Coleoptera) are classified into 166 families worldwide and more than half have been recorded in Malaysia (Chung *et al.,* 2010).

Diversity is not only observed in numbers but the types of size, shape, colour and even various types of habitat are also diverse in beetles (Triplehorn and Johnson, 2005). Beetles can be the smallest, biggest, and bulkiest insects. Many small beetles are found in leaf litter or soil thus, they are relatively difficult to extract and study.

Triplehorn and Johnson (2005) stated that one of the most distinctive features of the Coleoptera is the structure of the wings. Most beetles have four wings with the thick, leather, hard and brittle front pair called elytra. The hind wings usually longer than the front wings which play an important role as self protection.

Beetles are often used as a group to characterise terrestrial habitats or communities, especially in the tropical ecosystem (Stork, 1991). Due to their high diversity, it is interesting to investigate the assemblages of beetles at different levels of a habitat. Different beetle groups may occupy different levels of a habitat, from the ground to the top level of the canopy (Chung, 2004).

Beetles occur in most terrestrial and freshwater habitats (Lawrence and Britton, 1994). Beetles are important parts of most natural terrestrial and freshwater ecosystems. They have important effects on agriculture and forestry, and useful model organisms for many types of science. A better understanding of biodiversity of beetles will enhance our knowledge of the world and provide many practical applications (Foottit and Adler, 2009).

Order Coleoptera was chosen because there is lack of research about this order in Mount Serambu. Hence, the data that recorded can help in future study for other researchers.

The objectives of this study were:

- to determine the diversity of beetles at Mount Serambu, Bau, Sarawak.
- to identify the abundance and rare genus or species of beetles at Mount Serambu.
- to compare the species diversity of beetles between lower and upper elevation.

This study was carried out to test the hypothesis that there is a significant difference between species diversity of beetles in lower and upper elevation at Mount Serambu, Bau, Sarawak.

H_o: There is no significant difference between species diversity of beetles at lower and upper elevation in Mount Serambu.

H_A: There is a significant difference between species diversity of beetles at lower and upper elevation in Mount Serambu.

CHAPTER 2

LITERATURE REVIEW

2.1 Diversity and Abundance

Species diversity and biodiversity are widely used terms in ecology and natural resource management (Hamilton, 2005). Species diversity is the most commonly used representation of ecological diversity. In general, there have been two approaches to measuring species diversity, both of which incorporate information on the number of species (species richness) and the relative abundances of individuals within each species (species abundance). One method has been to construct mathematical indices broadly known as diversity indices and another is, involving comparing observed patterns of species abundance to theoretical species abundance models (Hamilton, 2005).

The International Convention on Biological Diversity (2003) noted that biological diversity means that the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which the part they are includes diversity within species, between species, and of ecosystems.

2.2 Coleoptera (Beetles)

There are four major groups of beetles which are Archostemata, Myxophaga, Adephaga and Polyphaga (Grimaldi and Engel, 2005). Polyphaga is the most diverse group in beetles which contain high species diversity. There are 102 families within this group and consist of 315,000 species that represents almost 90% of beetles diversity. Besides, Archostemata is specialised as wood borers. The largest family in this group is Cupididae, comprising of nine genera and 30% species worldwide. Approximately, 10% of all beetles are Adephaga. Carabidae is the largest family with 40,000 species from other nine families of Adephaga. There are 45,000 that have been described and most of them are Hydradephaga (water beetles) and Geadephaga (ground beetles). The smallest group is Myxophaga with only 65 recent species and five families. Most of them are aquatic and semi-aquatic beetles. Normally they can be found at the edges of the streams and rivers, in the splash zones of rapids and waterfalls, and in seepages (Grimaldi and Engel, 2005).

Most of the order Coleoptera is holometabolous which is having a complete metamorphosis. Hence, the beetles have complete development which includes four life stages which are as an embryo or egg, a larva, a pupa and an as adult (Gullan and Cranston, 1995). Most larvae of beetles are campodeiform or scarabeiform, some of them are platyform and elateriform but only a few are vermiform (Triplehorn and Johnson, 2005). The life cycle in this order varies in length from four generation a year to another generation in several years. Most of the species have one generation per year (Triplehorn and Johnson, 2005). Interestingly, the beetles can produce some sound in four principal ways such as in course of normal activities (flying and feeding), by striking some part of the body against the substrate, by stridulation and also by chemical reaction from the body (*Brachinus*) (Gullan and Cranston, 1995).

Based on the study done by Chung *et al.* (2010) in Maliau Basin, Sabah, the diversity of beetles was considered diverse and interesting. There were 27 families from 582 specimens were recorded during seven days sampling. The most prominent family was Staphylinidae, followed by Pselaphidae and Scydmaenidae. There are eight families from macro beetles were recorded through light trapping which were Scarabaeidae and Cerambycidae as the common families. Interestingly, the most common species encountered was *Oxyropterus audoniwi*, a giant click beetle from family Elateridae (Chung *et al.*, 2010).

The similar study was also conducted by Cassie (2007) at Kubah National Park, Sarawak, where a total of 609 individuals were recorded representing 123 species from 18 families by using five collecting methods. The most diverse and common group was Scarabaeidae with 339 individuals caught. However, the most abundant species was carabid beetles, *Colpodes fryibates* (F: Carabidae) represented by 10.5% of the total individuals caught.

According to Chung *et al.* (2000), in his study on the diversity of beetle assemblages in different habitat types in Sabah summarized that the overall diversity of beetles is high in primary forest, logged forest, acacia plantation and oil palm plantation types from different types in Sabah. Based on his study, a total of 8028 individuals beetle consisted of 1711 species from 81 families were sampled. Among these habitats, the oil palm plantation was most severely affected (Chung *et al.*, 2000).

The natural habitats for the beetles are usually influenced by human agricultural activities (Dagobert *et al.*, 2008). The presence of Coleoptera in each of agro ecosystem is depends on their ecology and numbers vary according to the habitat. However, some of families and species are very common in various agro ecosystems (Dagobert *et al.*, 2008).

2.3 Upper Elevation and Lower Elevation

The study of beetle was interested because they have high diversity at lower and upper elevation (Chung, 2004). There are different groups of beetles that occupy at different elevations which are lower, middle and upper elevation. Based on the study of Chung (2004), the most abundant family of beetles found at the ground level was the dung beetles (F: Scarabaeidae). A total of 26 individuals of *Onthophagus semiaureus* were captured and 15 of individuals of *Onthophagus* sp. were caught. Other than that, Chung also recorded five different families (Hydrophilidae, Staphylinidae, Mordellidae, Leiodidae and Biphyllidae). From the specimens, only family Hydrophilidae and Staphylinidae were recorded at all elevation while family Biphyllidae was captured at lower and upper elevation but the rest all families was abundant at the lower elevations.

2.4 Mount Serambu

Mount Serambu is populated by ancestral villages of the Serambu which is ethnic Bidayuh in the Bau Distric of Sarawak as shown in Appendix 1 (Community Action Global Impact, 2012). Most of the villagers moved downhill in order to improve their life thus, lead to the rapid development for housing and also for quarry activities. They use the lower of mountain as their agricultural site and are allowed to collect plants and herbs for traditional medicinal uses as long as they are being monitored. This mountain consists of many giant bamboos that grow around and the abundance of *Amorphophallus* which is the tallest flower in the world found at the foothills (Bombastic Borneo, 2011).

The Mount Serambu was formerly covered entirely with mixed dipterocarp forest which consists of small patches of heath forest and rocky peaks (Malaysian Nature Society, 2010). The vegetation has been changes from the past (Malaysian Nature Society, 2010).

The lower elevation has been altered by humans since a long time ago for modernisation purpose. Many of the timber were cut and used for building and other uses. In the recent, the forest is very open due to removal of the largest and tallest trees. Many plants become grooves such as Tapang (*Koompasia excels*) tree because this tree are not cut for wood. The fruit trees such as 'durian' and 'langsat' have also been planted at lower slopes. Majority of plants at understory can be classified as herbaceous with proliference of ferns, aroids and *Amorphophallus*.

The upper elevation is different in terms of vegetation and geological types compared to the lower elevation. The upper slopes are very steep and littered with boulders. Besides, Tapang still dominate and more diverse as the tallest tress rather than other large trees species existed at that area. Some plant such as *Arenga* palms and bamboos are very common here but large areas seem have been disturbed either by clearing or by natural landslips. Most of the vegetation has been altered drastically because only a few of the original forest remaining. In the past, the ridge tops have been formed (Malaysian Nature Society, 2010). These abandoned farms become colonised by combination of native secondary scrub vegetation such as *Dillenia* and *Melastoma*, addition by exotic plants which are *Bauhinia, Ixora, Garcinia,* and *Nephelium*. The exotic plants have been dispersed naturally by wind. Elements of heath vegetation are visible such as *Nepenthes, Ixora* and *Calophyllum* (Malaysian Nature Society, 2010).

Interestingly, the mount is the site of the cottage built by Rajah Brooke in between 1848-1850 to escape the heat of Kuching (Community Action Global Impact, 2012). Moreover, the world famous naturalist, Alfred Russel Wallace (1823-1913) had stayed back in this mount in 1855 and had described it in exuberant detail in The Malay Archipelago. Mount

Serambu approximately 1,500 covered hectares and surround by virgin tropical rainforest that rich with biodiversity of plants and animals. Mount Serambu has a warm climate which is hot by day and cold by night.

CHAPTER 3

MATERIALS AND METHODS

3.1 Study Site

The study was conducted at Mount Serambu in Bau, Sarawak (Figure 3.1). Mount Serambu is situated about 31.5 km from Kuching District. The nearest places to Mount Serambu are Pelaman Segah (2 km East), Kampong Kopid (2 km East), Kampong Peninjau Baharu (2 km North), Kampong Podam (2 km West), and Kampong Merimbeh (2 km West). It is located at 01° 25' 48.1" North in Latitude and 110° 13' 20.0" East in Longitude. This mountain is about 347 meters above sea level.

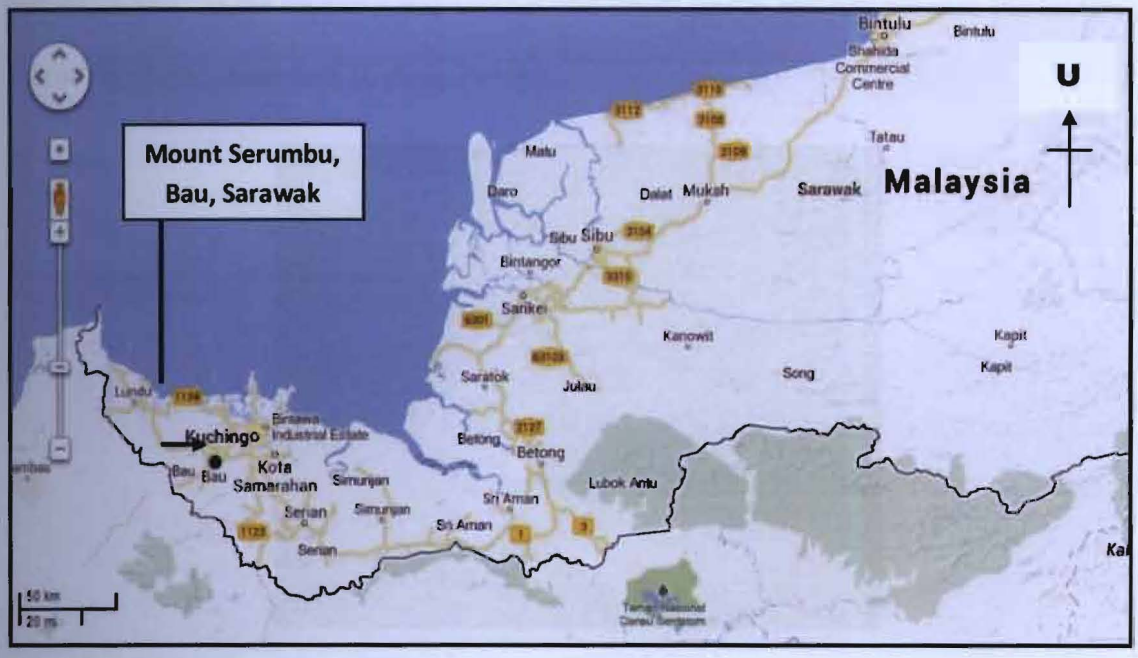

Figure 3.1: Map of Mount Serambu (Source: Google map).

3.2 Field Methods

The study was conducted for six days at upper elevation and six days at lower elevation then same goes to another 12 days. The samples were sorted and only specimen from the Order Coleoptera were segregated and identified. In this study, two methods were employed within 22 days of sampling from 19 January until 29 January 2013 and 4 February until 14 February 2013.

3.2.1 Beating Method

Beating was the most effective method to collect the beetles especially the small beetles as shown in Figure 3.2. A stout stick was used to beat the shrubs or even the dead branches with the white cloth which act as the tray. When the plants was shaken or beaten randomly, the beetles were fall into the tray and they were caught immediately to avoid them escaped. By using this method, it cannot be done when the vegetation was wet either early in the morning dew or after the rain. In order to make it more efficient, this method undergoes two hours early in the morning and another two hours late in the day because the insects less active during these time (Upton, 1991).

Figure 3.2: Sampling by using beating tray.

3.2.2 Hand Picking

Collecting the beetles using by hands was a most profitable way if the other methods not producing as many specimens in a given time. Otherwise, a great deal can be learned about the habits and life history of the beetles when collecting them individually by hands (Upton, 1991). This method was undergoing two hours early in the morning and another two hours late in the day at the same time when the beating method was carried out. The beetles were picked randomly along the pathways.

3.2.3 Trapping Method

There are two main principles in trapping method which are mechanical collection and attraction. The beetles were trapped when they made the movement either in the air or on the ground were mechanically intercepted and they were rest restrained, dead or alive. These traps were operated either actively or passively. The active traps can be defined by catching the moving beetles randomly which collided with, fall into or sucked into them while the passive traps were attract the beetles by means of baits, lures, lights, colours or shapes (Upton, 1991).

Modified Pennsylvania Light Trap

The most popular catching traps for insects was Modified Pennsylvania light trap which consists of powered by 160 watt high pressure mercury vapour lamp with clear glass envelope and emitting light in a complete hemisphere. The best killing agent is used such as chloroform in the light traps in order to kill the beetles (Upton, 1991).

Two units of the Modified Pennsylvania light trap were used to conduct this study (Figure 3.3 and Figure 3.4). Both of the light traps were put at the open space to attract more

beetles and the distance between each trap was about 20 meters approximately. Traps were left to function from 1800 to 0600 hours and the dead trapped specimens were collected every morning. This method cannot be conducted in the moon light because there was the competition between the light of moon and the light from Modified Pennsylvania light trap. The coordinates of both the light traps at lower and upper elevations was taken (Table 3.1).

Table 3.1: The coordinates of light traps at lower and upper elevations.

Light trap	Lower elevation		Upper elevation	
	A	B	A	B
North	01.43099°	01.43001°	01.43019°	01.43005°
East	110.22150°	110.22214°	110.22173°	110.22150°
Elevation (meter)	48	51	347	350

Figure 3.3: Sampling by using two Modified Pennsylvania light traps at upper elevation (Left: Light trap A and Right: Light trap B).

Figure 3.4: Sampling by using two Modified Pennsylvania light traps at lower elevation (Left: Light trap A and Right: Light trap B).

3.2.4 Capturing Effort (CE)

The capturing effort for each method per day:

Beating Method

CE = Amount of equipment x spend hours x man power

= 2 x 4 x 2

= 16

Modified Pennsylvania Light Traps

CE = Amount of equipment x spend hours x man power

= 2 x 12 x 2

= 48